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# MARKET CONCENTRATION AND VERTICAL COORDINATION IN THE PORK INDUSTRY: IMPLICATIONS FOR PUBLIC POLICY ANALYSIS

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**Abstract**

The pork industry has become increasingly concentrated and this has spawned concerns over the exercise of market power. A neglected area of research in agricultural economics is how public policy operates differently under imperfect competition. This paper considers that issue for the pork and swine industries. Drawing on work in economic theory and empirical research for other agricultural industries the paper argues that policies can be categorized into those independent of market conduct and those dependent on market conduct. Policy should maintain market open to trade, avoid the use of quantitative policies in favor of price policies and demand expansion.

## MARKET CONCENTRATION AND VERTICAL COORDINATION IN THE PORK INDUSTRY: IMPLICATIONS FOR PUBLIC POLICY ANALYSIS

Agriculture has been experiencing rapid structural change with increased concentration and more use of vertical coordination. Few sectors have been as dynamic as the pork sector. While much concern has been expressed over the effects of concentration and vertical coordination on pricing, the implications of these trends for public policy selection and implementation have not been discussed. Yet, economic theory suggests that the effects of policy can differ under alternative forms of market conduct. Decisions by policy makers regarding policy selection become much more difficult when imperfect competition prevails.

This paper considers how the impacts of various types of policies used in agricultural markets differ when the potential for imperfect market conduct is recognized. The U.S. pork and swine markets provide a concrete tool to develop these issues. The pork industry has become more concentrated with greater use of vertical coordination and integration. These structural characteristics create the potential for both oligopoly and oligopsony conduct. There is a vertical relationship between the processed good, pork, and the intermediate input, hogs. Finally, pork is traded in international markets, while international trade in live swine is sufficiently limited to be considered non-traded[1].

The main conclusion is that when there exists a potential for oligopoly or oligopsony conduct in a processed good like pork, certain types of policy interventions should be avoided if policy is intended to benefit bulk commodity producers, swine growers. The paper begins with a

[1]Regionally, U.S. imports of Canadian hogs is often significant. USDA/ERS estimated that Canadian hog imports in the fourth quarter of 1998, took at least $1 off Mid-West packer bids.

brief review of the trends in the swine and swine packing industries which have raised concerns over potential oligopoly-oligopsony conduct. Then the discussion shifts to studies which examine whether imperfectly competitive conduct is exercised in the meat packing industry. The third section modifies frameworks which have analyzed the impact of imperfect competition to consider several possible policy interventions on consumers, packers, and swine growers.

Structural Change in the U.S. Pork and Swine Industries

During the past 10-15 years tremendous structural changes have occurred in both swine packing and swine growing operations. These changes have caused anxiety among independent swine growers over imperfect market conduct.

One change is that the number of establishments raising hogs has fallen from 666,500 in 1980 to 98,460 in 1999. Within this general decline there have been regional shifts, grower specialization, increased size, and increased vertical coordination. Although North Central states continued to dominate swine production during the 1990s their relative importance declined. Beginning in the 1980s Southern states, particularly North Carolina, experienced a rapid rise in hog production. More recently Western states have grown in importance, Oklahoma in particular. These regional shifts are associated with increased specialization. The traditional farrow-finish operation is less widely used. Midwestern states tend to specialize in the grower-finishing tasks, because of feed supply proximity and excess shackle space. Neighboring regions tend to specialize in gestation and farrowing. Another trend is increased size due to economies of scale. Summary statistics for 1993 do not report 2,000 head operations, but by 1995 such operations represented 2 percent of hog operations and 37 percent of the inventory. Since 1985, the number of small operators has fallen by over one-half. Increased vertical coordination is also a new

feature of the swine industry. Previously independent swine growers delivered hogs for cash sales in local markets. Presently the dominant situation is that growers form some arrangement with specific packers. Precise estimates are not available, but reliable estimates are that roughly two-thirds of animals slaughtered are either directly owned by packers or sold under a contract of some form. With the large number of animals under contract at proprietary prices, independent growers express concern over the possibility of artificially lower prices and market foreclosure.

Structural change also occurred in the swine packing industry. Between 1985 and 1997 the number of hog slaughter firms fell from 338 to 184 while the number of plants declined from 403 to 218. On a percentage basis the decline was more rapid for the plants of smaller firms. The percentage decline for plants of all firms was 45 percent. Plant numbers run by the top 4 firms fell 17 percent and plant numbers for the top 20 firms fell 12 percent (USDA/GIPSA).

With the heterogeneity of the packing industry changes in total firm and plant numbers can be misleading. Concentration ratios and Herfindahl indexes adjust the total numbers by size as measured by hog procurement. The 4-firm concentration ratio indicates the share of procurements accounted for by the largest 4 firms. Between 1985 and 1997 that ratio rose from 32.2 to 54.3. The concentration ratio at the 8-firm level rose from 50.8 to 75.7. In the Structure-Conduct-Performance (SCP) methodology these concentration ratios would classify the swine packing industry as one of moderate concentration. Another measure of industry concentration is the Herfindahl index which weights firms by the square of market share. Over the 1985 to 1997 period the Herfindahl index for hog slaughter rose from 456 to 969. This index can be used to imply the number of equal sized (symmetric) firms in an industry (Helpman and Krugman). That is, if all firms were reformed into symmetric firms, how many would exist. The Herfindahl index

data suggest that for 1985 the industry would consist of 22 symmetric firms. By 1997, the symmetric firm equivalent had fallen to 10.

Evidence of Imperfect Competition in Meat Packing

The concentration ratios and Herfindahl index suggest the potential for imperfect market conduct. They do not prove or disprove the existence of that conduct. Studies for soybean crushing by Yamazaki, Paarlberg, and Thursby and by Deodhar and Sheldon with similar concentration find no evidence of imperfect market conduct. Economic theory indicates an inverse correlation between firms numbers and the exercise of market power. A staff paper by Paarlberg, et al., shows using a naive Cournot model how declining packer numbers are linked to mark-downs on the hog price assuming oligopsony conduct. They calculate that as symmetric packer numbers fall from 20 to 10, the mark down on the hog price could increase from 5 percent to 15 percent. Declining packer numbers from 10 lead to increasingly larger mark-downs. Economic theory also suggests reasons why the relationship estimated by Paarlberg, et al., might not actually reflect the behavior of an industry. Major forces which can affect the relationship between firm numbers and market power include: tradeability, contestibility, economies of scale, and product substitution.

Because economic theory does not give clear predictions, agricultural economists have attempted to test for the presence of oligopoly and oligopsony conduct in markets where concentration data suggest it might be present. As concentration ratios in cattle slaughter are higher than those for swine, and have been high for many years, most research focuses on cattle packing. We are unaware of any estimates of market power for the swine industry. The results obtained from econometric work on cattle are ambiguous. Most studies do find some evidence of

oligopsony power. Examples include: Azzam; Azzam and Park; Koontz, Garcia, and Hudson; Schroeter; and Schroeter and Azzam. They do not find oligopoly power. This is probably because, as shown later, international trade can erode market power.

Two recent studies by Muth and Wohlgenant and by Whitley question the suggestions of oligopsony conduct in the other research. Both studies include factors omitted by previous studies. Muth and Wohlgenant allow for variable proportions technology and find no evidence of oligopsony conduct for the 1967-93 period. Whitley argues that quality differences and the inability of cattle buyers to exactly observe quality accounts for the estimates of oligopsony conduct in earlier studies.

Paul analyzes meat packing in aggregate. While finding limited evidence of imperfect market conduct, Paul argues that inclusion of scale economies, technical change, and trade diminish the market power.

An argument made against an increase in market power in swine packing as concentration increases, is that concentration allows packers to gain economies of scale. As firms concentrate the per unit costs fall. Cost savings are reflected in reduced pork prices and increased hog prices. This offsets the potential increased use of market power. Recently estimated plant cost functions for swine packing by MacDonald and Ollinger find extensive economies to scale which are of modest size and have increased over time. Large plants have increasing cost advantages over smaller plants. Left unanswered is whether the scale effect is large enough to dominate the market power effect.

Another argument raised is that concentration and increased vertical coordination by swine packers could unleash technological changes which would lower per unit costs. This belief

comes from the observation that the structural changes in the poultry industry beginning in the 1940s were large enough to boost industry profitability while driving down retail poultry prices. It assumes that independent swine producers and current packers have not captured potential efficiencies because their current scale of operation is too small. Perhaps that is the case. But a replication of the experience of the poultry industry over the last 50 years is not an inevitable outcome of concentration in the pork industry.

Inconclusive results of studies testing for the presence of imperfect market conduct, raises the issue of whether policies can be categorized into those that are independent of the market conduct and those with impacts contingent on the conduct assumption. If such a separation can be made, policy makers will have a set of policy instruments where knowledge of the market conduct is not as critical when evaluating policy options.

Policy in Imperfect Markets

How policy, especially trade policy, operates in imperfect markets is a relatively new research area which blends the New Industrial Organization theory with Trade theory. Very little work has been done by agricultural economists because the prevailing view has been that agricultural markets are characterized by perfect competition (Antle).

The approach taken in this section is to modify and reinterpret some well-know frameworks from the economics literature and some work in agricultural economics in the context of pork and swine. Throughout the discussion there are some common assumptions. First, the markets for swine and pork are vertically linked. Packers buy hogs to kill and the processed output is pork. Swine growers are price-taking agents who supply animals to packers according to a supply function. Swine are treated as a non-traded input which abstracts from U.S. swine

imports from Canada. Packers make pork which is traded in international markets. Packers have oligopsony power and have the potential to exercise oligopoly power.

An important point of departure is the traditional trade theory proposition that free trade for a country unable to affect the world price can erode firm market power (Caves and Jones). This can be shown for both an export and an import commodity. The import case is depicted in Figure 1. To keep the graph clear assume there is a domestic monopolist packer producing pork with a marginal cost function denoted MC. Domestic demand for pork is given by D with an associated marginal revenue of MR. Begin with the economy being closed. The monopolist sets output of pork $Q_m$ by equating marginal revenue to marginal cost. With pork output of $Q_m$ the domestic market clearing price under autarky is $P_m$. This country is assumed to be a price taker in the world market as shown by the fixed world price $P_w$. When the country allows trade the monopolist must compete with imports at $P_w$ and the domestic price falls to that level with domestic use rising from $Q_m$ to $C_c$ and domestic output increasing from $Q_m$ to $Q_c$. Pork imports are $C_c$ - $Q_c$. Both pork production and use are higher. In the vertically related hog market the pork production increase requires more hogs for slaughter and bids the hog price higher.

Thus, opening the economy to trade erodes the mark-up power of the packer. Disguised in this framework is that any monopsony conduct is <u>not</u> eroded by trade. The packer treats the pork price as given, but influences the animal price by setting swine purchases using the positively sloped marginal expense of input. Since the marginal expense of input relation lies above the supply function swine purchases are lower than under perfect competition and the animal price is lower. While opening the pork market to trade raises the hog price, there is still a mark-down due to monopsony. This is probably one reason why econometric studies of beef packing reject mark-

up pricing, but find evidence of oligopsony conduct.

The question addressed by Bhagwati, is if a nation is going to restrict imports and firms are imperfect competitors, does it matter whether a tariff or a quota is used? Bhagwati shows that with imperfect competition it matters greatly because tariffs and quotas are not equivalent. A quota set at the free trade level affects prices under imperfect competition, but would be non-binding under perfect competition and not affect the price. This occurs because a quota and a tariff affect the reaction of foreign suppliers differently. Figure 2 reproduces the small open importing country of figure 1 and compares a tariff and a quota which give the same level of imports. The tariff (t) raises the domestic price from $P_w$ to $P_w + t$. Production expands from $Q_c$ to $Q_t$ while use contracts from $C_c$ to $C_t$. These adjustments result in reduced imports, from $C_c$-$Q_c$ to $C_t$-$Q_t$. A quota can achieve the same level of imports. This is captured by a shift in demand from D to $D_q$. The monopoly swine packer now sees a residual demand (the demand less the import quota) and can set pork output using that residual demand. Pork output is set where the packer's marginal cost equals the marginal revenue of the residual demand, output $Q_m$, which is lower than the free trade output. The domestic price rises from $P_w$ to $P_m$ causing a loss in consumer welfare. Domestic use of pork is $C_m$, which is lower than the free trade level. The domestic price rises under both policies, but the increase is much larger under the quota policy so the welfare loss to consumers is larger as well.

The implications of the two policies for the hog market are very different. Under the tariff policy pork output rises and so does the hog price as slaughter expands. This means an increase in the welfare of swine producers. With the quota policy, the much larger price increase is a result of mark-up pricing due to a reduction in pork output, according to the residual demand.

Reduced pork output requires fewer animals and the hog price falls causing a welfare loss to swine producers.

The difference between a tariff policy and a quota policy on the welfare of producers of a non-traded intermediate input is presented by Paarlberg and Lee. They examine the implications of U.S. import controls for lamb meat on the welfare of U.S. lamb growers. Two policy options analyzed compare a proposed 4-year tariff and quota. Under the tariff policy lamb packers increase value-added $113.1 million and lamb growers gain a producer surplus of $239.4 million. With the quota policy, packers increase value-added $441.6 million. In the first two years, lamb growers experience a welfare loss of $48.4 million, as packers cut slaughter. Since the quota becomes relatively more restrictive in years 3 and 4, lamb growers benefit by $77.1 million. So, under the tariff, both packers and grower welfare increases by $113 and $239 million, respectively; over the 4-year policy. Under the quota, packers' value-added increases $442 million, while growers net benefits increase by $29 million over 4 years with the gain to lamb growers occurring from an increasingly restrictive import quota.

Krishna and Thursby consider the impact of imperfect competition versus perfect competition when the policy is an export restraint imposed on foreign suppliers. They show that an export restraint set at the free trade level of exports either creates market power where none existed prior to the policy, or, enhances existing market power. The export restraint segments the market, and the domestic price rises as a result. Because the export restraint creates a flat segment in the marginal revenue curve, domestic output remains unchanged over a wide range of trade. The export restraint can vary from very restrictive to very liberal, without causing a change in the level of domestic output. The domestic price for pork rises, and the benefit is entirely

captured by packers because there is no change in pork output, hence hog slaughter.

A general conclusion from these frameworks is that if an objective of the policy is to improve the welfare of intermediate good producers -- swine growers -- when there is potential downstream market power, quantitative based policy intervention should not be used. Price policies -- tariffs, taxes, and subsidies -- are preferred when potential market power is present. In the case of price intervention, research has shown that the sign of the intervention -- a tax or subsidy -- is quite sensitive to industry characteristics reflected in the model specification.

Brander and Spencer present a case where, if the goods are strategic substitutes (an increase in firm i's strategic variable lowers firm j's profit), the optimal trade policy intervention is an export subsidy. These results flow from the inability of oligopolists to pre-commit to higher levels of output. Giving the one government the first move changes the nature of firm interaction. The government pays an export subsidy to its domestic firm which shifts that duopolist's best response function to obtain a Stackelberg equilibrium. In this case there is profit shifting from the rival firm. Helpman and Krugman explain this behavior as reflecting the situation that the actual marginal revenue is flatter than the perceived marginal revenue.

The Brander and Spencer model examines the case where a home country duoplist and a foreign duopolist compete in a third country market. Yet, the framework and the lessons learned about the equilibrium shift can be applied to subsidies given to firms competing in the domestic market. Pork packers do not receive subsidies from the Federal government, but are often given subsidies by State or local governments in the form of tax credits, investment incentives, or infrastructure subsidies. The Cournot game described by Brander and Spencer is frequently interpreted as a capacity setting game (Tirole).

Imagine a situation where the two duopolists are home country pork packers and the demand they face is an aggregate of linear domestic and export demands for a homogeneous product, pork. To draw a clear figure, it is assumed that each firm has a constant marginal cost and that the marginal cost of packer 2 is below that of packer 1. The initial equilibrium with no subsidies paid for this scenario is illustrated in Figure 3 where $B_1^0$ and $B_2^0$ are the linear best response functions for the two packers (Appendix equations (A5) and (A6)). Iso-profit contours are denoted $\Pi_1^0$ and $\Pi_2^0$, respectively. With no subsidies paid the Cournot-Nash equilibrium is given as point $C^0$ with outputs (capacities) by packers 1 and 2 of $Q_1^0$ and $Q_2^0$.

Now assume packer 2 obtains a subsidy, $s_2$, to expand capacity, perhaps a tax credit. This subsidy shifts packer 2's best response function upward to $B_2^1$. As a result the equilibrium determined by the intersection of the best response functions changes to $C^1$. Packer 2 expands output to $Q_2^1$ and packer 1 reduces output to $Q_1^1$ with total industry output higher. This can be verified by simultaneously solving Appendix equations (A5) and (A6) for $Q_1$ and $Q_2$, then summing. Packer 2 moves to a higher iso-profit contour $\Pi_2^1$ and packer 1 moves to a lower iso-profit contour not shown in figure 3. With a higher total output the price of pork is lower and the price of hogs is higher. Thus, consumers gain, swine growers gain, and packer 2 gains. Packer 1 and taxpayers pay for the policy.

Suppose packer 1 is also given an equal subsidy so that $s_2 = s_1$. This shifts packer 1's best response function outward to $B_1^1$. The new equilibrium is given by point $C^2$ where the policy shifted best response functions for both packers intersect. Compared to the initial equilibrium both packers have expanded output, $Q_1^2$ and $Q_2^2$. Higher output of pork translates into a lower price for pork and a higher price for hogs. What is particularly interesting about this solution is that

both packers move to inferior iso-profit contours — $\Pi_1^2$ and $\Pi_2^2$ -- because the subsidy policy induces an output expansion which is contrary to their interests. Thus, in this scenario consumers and swine growers gain while both packers and taxpayers lose.

This is a Prisoner's Dilemma game. Both packers would be better off to cooperate and form a binding agreement not to accept subsidies. However, it is in the individual packer's interest to take the subsidy. When they both do so they are worse off. By assumption, packer 2 has a lower marginal cost which can give it a strategic advantage. Packer 2 may be more able to absorb the losses and knows that if it can buy packer 1, it can increase its market power by becoming a monopolist. Thus, the subsidy policy may contribute to packer concentration and if that happens, swine growers and consumers may not experience a welfare improvement.

With pork being internationally traded and hogs mostly non-traded, an argument could be made that duopsony is a better description of the pork/swine sector than the duopoly described in Figure 3 because, as shown in Figure 1 trade can erode the mark-up pricing. The research testing for market power in beef also suggests that if market power is exercised, it is in the form of oligopsony conduct. In the case of strategic substitutes -- Cournot behavior -- when packers take the pork price as given but affect the hog price, the results shown in Figure 3 transfer. The strategic variables are redefined as slaughter, and the best response functions shift in the same directions (Appendix equations (A8) and (A9)). Subsidies to packers raise slaughter and the price of hogs rises.

Eaton and Grossman demonstrate that the Brander and Spencer results for trade policy are sensitive to the assumption of strategic substitutes or complements. Where Brander and Spencer showed that when goods are strategic substitutes, the optimal trade policy intervention is an

export subsidy, Eaton and Grossman demonstrate that when a domestic duopolist competes with a foreign duopolist in a third country market and the goods are strategic complements (an increase in firm i's strategic variable increases firm j's profit), the policy which raises the home country's welfare is an export tax. Since the welfare increasing trade policy flips, a critical question is whether the policy also flips when the duopolists are both domestic firms?

The same model as presented previously is used to investigate this question with the modification that the two packers now treat their pork as strategic complements. That is, there is price competition. The initial no-subsidy equilibrium, $E^0$, is shown in Figure 4 with prices $P_1^0$ and $P_2^0$ for packers 1 and 2, respectively. The best response functions are now positively sloped (Appendix equations (A13) and (A14)) and the iso-welfare contours are indexed in the opposite direction.

Again, assume at first, that only packer 2 obtains the subsidy, $s_2$. The best response function shifts downward as for a given price by packer 1, packer 2 will sell pork at a lower price. The new equilibrium is denoted $E^1$ and shows the prices by both packers are lower as the subsidy expands output. Both packers are on lower iso-welfare contours. This outcome contrasts with the first case where packer 2 gained if the subsidy was exclusive to that firm. If the subsidy is also given to packer 1, that firm's best response function shifts upward to achieve an equilibrium at $E^2$. Pork output is greater and the pork prices offered by both packers are lower. Profits of both packers are lower. Consumers benefit from the lower prices. Swine growers benefit from the output expansion induced hog price increase.

In the case of duopsony the best response functions shift differently (figure 5). In this case packers take the pork price as determined by the world market and compete with one another

using the price paid for hogs. If a subsidy is paid to packer 2, given the price of hogs set by packer 1, packer 2 offers a higher price. Thus, the best response function shifts upward from $B_2^0$ to $B_2^1$ (Appendix equation (A18)). The initial equilibrium $E^0$ gives hog prices $H_1^0$ and $H_2^0$ paid by packer 1 and 2, respectively. With the subsidy to packer 2, the prices paid for hogs are determined at $E^1$ and both packers offer higher prices, $H_1^1$ and $H_2^1$. A subsidy to packer 1 shifts its best response function to the right from $B_1^0$ to $B_1^1$ because for a given hog price offered by packer 2, packer 1 will offer a higher price with the subsidy (Appendix equation (A17)). The new equilibrium is shown as $E^2$ with hogs prices of $H_1^2$ and $H_2^2$. Thus, swine growers benefit from subsidies given to one or both firms.

The two frameworks suggest some general observations. The policy intervention results in vertical profit shifting between packers and swine growers. Swine growers gain from subsidies to packers as pork output (slaughter) rises. In effect, the subsidies are offsetting the distortion of packer market power in either the pork market or the hog market. In a perfectly competitive market subsidies to packers would boost the derived demand for hogs and raise the price. While the magnitudes of the impacts will be sensitive to the market conduct, if the policy objective is to raise the hog price, subsidies to packers will do so regardless of the market conduct. There is a Prisoner's Dilemma for packers in the case of strategic substitutes, but not in the case of strategic complements. Consumers benefit from lower pork prices when packers have oligopoly power. Consumers do not gain if there is only oligopsony conduct since the pork price is determined by global market conditions. Taxpayers must pay the subsidy costs.

A policy which has been increasingly used by the United States is the tariff-rate quota (TRQ). Currently the United States has TRQ's on over 50 agricultural products, including many

meats (Skully). The tariff-rate quota combines elements of both a tariff and a quota intervention by using a quantitative trigger to escalate the applied tariff.

A tariff-rate quota intervention in vertically related markets with imperfect market conduct has been analyzed by Paarlberg and Lee using a quarterly model of the U.S. lamb meat and lamb markets. Five symmetric lamb packers have the potential to influence market outcomes under alternative trade policies through setting lamb slaughter. The results for lamb meat and lambs have applicability to the case of pork and swine.

The market impacts of the TRQ are a blend of tariff and quota effects as the policy is characterized by regime switching. When the quota is binding the lamb price can be forced down through the reassertion of oligopoly power as occurs for a pure quota and lamb growers can experience a welfare loss. There is an incentive for packers to reduce slaughter in order to trigger the quota and exercise their mark-up power rather than to accept quota under-fill. The larger the difference between the below-quota tariff and the above-quota tariff, the larger the range for the exercise of oligopoly power and the associated welfare losses for lamb growers. For example, lamb growers are estimated to lose $33 million in producer surplus the first two years. This is partially offset by gains in later years, but over four years lamb growers are $16 million worse off compared to keeping the existing small tariff.

The non-traded intermediate good's price (live lamb) is more unstable under the TRQ policy. The price of lambs is whipsawed depending on whether the quota is under-filled, filled exactly, or over-filled. When the quota is binding in the October quarter, the lamb price is $52 per cwt. The next quarter there is under-fill and the price jumps to $97 per cwt. This pattern of sharp quarter to quarter price swings continues through the model solutions.

When oligopoly power is present due to a tariff-rate quota, lower quotas are preferred by intermediate input producer over less restrictive quotas. This occurs because a more restrictive quota reduces the slaughter reduction. Lamb growers prefer no TRQ to one that sets a quota at the existing level of imports, but prefer a very restrictive quota over no quota.

The results for lamb meat and lambs suggest that if the policy objective is to boost the price of the animal, a pure tariff policy is preferred. While increases in the animal price may result from a quota or a TRQ, that is not assured. This is because those policies may allow packers to engage in mark-up pricing of meat using the residual demand. The pure tariff policy raises the meat price and the animal price, yet, forces packers to continue to compete with foreign producers.

A policy option high on the pork and swine industries list to boost prices, is export promotion of pork. Paarlberg, Haley, and Pritchett examine export promotion for pork on the U.S. pork and swine sectors using a monthly simulation model that allows imperfect market conduct. The model assumes that symmetric swine packers at time t = 0 set contract deliveries for time t = +5 based on forecast market conditions. At time t = +5 packers determine slaughter given actual market conditions, treating contract deliveries as given. Slaughter in excess of contract deliveries is purchased in the cash market.

The results show that a one-time monthly export promotion program of 50,000 tons boosts the prices for both pork and swine. The price of carcasses rises over 8 percent and that for cash swine rises around 12 percent. An important feature of the program is the relationship between program announcement and tenders. If the program is announced prior to setting contracts, the demand shift is anticipated and captured in contracting. The price paid for contract

animals is much higher, 13.8 percent, while that for cash animals is affected less, 11.5 percent. If the export program is unknown at time of contract, then the cash price rises more than the contract price because packers not having anticipated the demand increase must bid for animals in the cash market. The cash price is 12.1 percent higher and the price for contract animals is 11.6 percent higher. If an export program is announced, but not executed, the contract price rises as packers increase contracting. When the sales are not made, packers have too many animals and reduce cash purchases which lowers the cash price.

The welfare changes found by Paarlberg, Haley, and Pritchett mirror the price changes. When additional export sales occur, independent swine growers, vertically coordinated swine growers, and packers gain welfare. Consumers and taxpayers suffer welfare losses. These results are consistent in direction with those of a perfectly competitive market conduct. Allowing for imperfect competition does not alter the direction of changes in welfare resulting from an export demand shift.

Conclusions

Like several other agricultural sectors the pork sector has experienced structural changes in recent years that could lead to imperfect market conduct. Data show that concentration in hog slaughter is high and rising. Public policies can have impacts in imperfect markets that differ from those under perfect competition. Given the existing research base however, it is not possible to say for certain that the U.S. pork packing industry's potential market power is realized. Given the uncertainty over market conduct, this paper examines public policies when imperfect competition is assumed in an effort to winnow policies which are independent from market conduct, from those with effects that depend on market conduct.

One lesson is that an open border for a tradeable commodity like pork is critical. Trade in pork can undercut the ability of packers and processors to mark-up pork prices.

A related conclusion is that when there is potential oligopoly power, the type of border policy used is critical. Under imperfect competition, tariffs and quantitative restrictions are not equivalent. Quantitative restrictions, like quotas and tariff-rate quotas, which set a fixed level of imports or wide step in tariffs, allow firms with potential oligopoly power to set output along a residual demand. This results in a higher price than under a tariff for the same level of imports. Export restraints "voluntarily" requested by foreign suppliers create the same problem. When there is potential market power, taxes, tariffs, and subsidies are preferred over quantitative policies.

Subsidies given to packers result in profit shifting. Swine growers gain as the subsidies induce packers to expand kill, in effect offsetting the market power in either the pork market or the hog market. Similar impacts on the swine price would arise in a perfectly competitive market. The consequences of subsidies to packers under imperfect market conduct may differ from the perfect competition case. Under perfect competition packers should benefit from the subsidies. In the case of imperfect market conduct, the subsidies may induce packers to act against their interests, as expanding output either drives the pork price lower or bids the hog price higher. In the case of strategic complements packers lose from subsidy policy. In the case of strategic substitutes a packer gains if only it receives the subsidy. Thus, there is a Prisoner's Dilemma. Compared to when all firms are subsidized, packers are better off if no firm is subsidized, but each benefits if it alone is subsidized.

An implication of the strategic substitutes case is that tax incentives by local governments

to locate packers in their communities may accelerate concentration. If packers foresee that the subsidy policy will ultimately lower industry profits, they may decide to acquire weaker rivals in order to increase market power to offset the subsidy.

Tariff-rate quotas which are popular following the Uruguay Round, behave more like quotas than tariffs. A TRQ may create market power or enhance existing market power. When the industry uses a non-traded input, like hogs, owners of that input may suffer. For owners of the non-traded input, a pure tariff is preferred over a TRQ. If a TRQ policy is used, the more restrictive the better, as the more restrictive policy is more likely to require increased use of the non-traded input.

Policies which shift demand, like export promotion, appear to benefit both the packer and the animal producer just like in the case of perfect competition. While the magnitudes may differ, the impacts are independent of the conduct assumption. A critical feature in industries like pork with vertical coordination is the timing of the program announcement and execution. A program announced far enough ahead to allow packers to adjust contracts benefits both independent and contract growers, but contract growers fare relatively better. A surprise export promotion program will also benefit both types of growers with independent growers reaping the larger gain.

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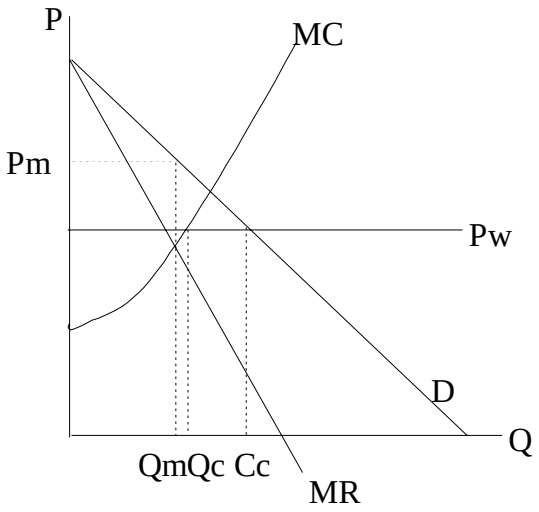



Figure 1: Trade Erodes Market Power

Figure 2: Non-equivlaence of a Tariff and Quota under Imperfect Competition

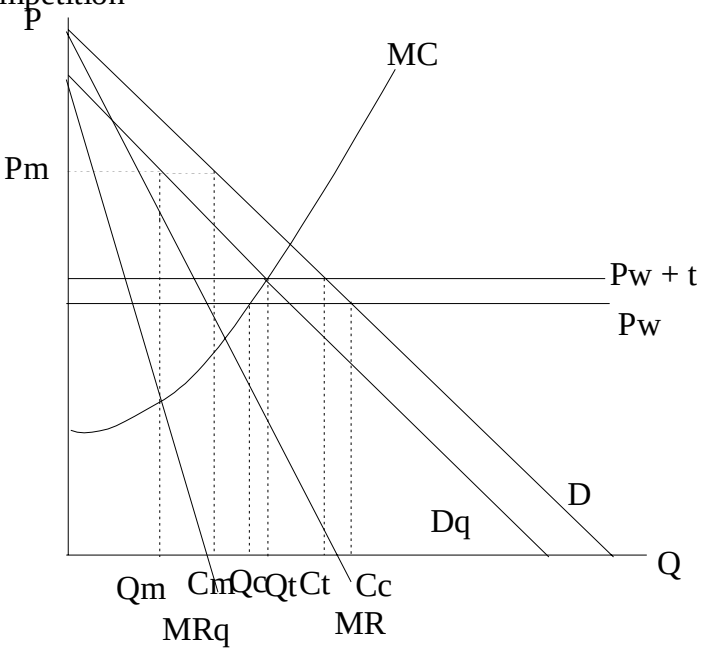


Figure 3: Domestic Subsidy with Duopoly: Strategic Substitutes

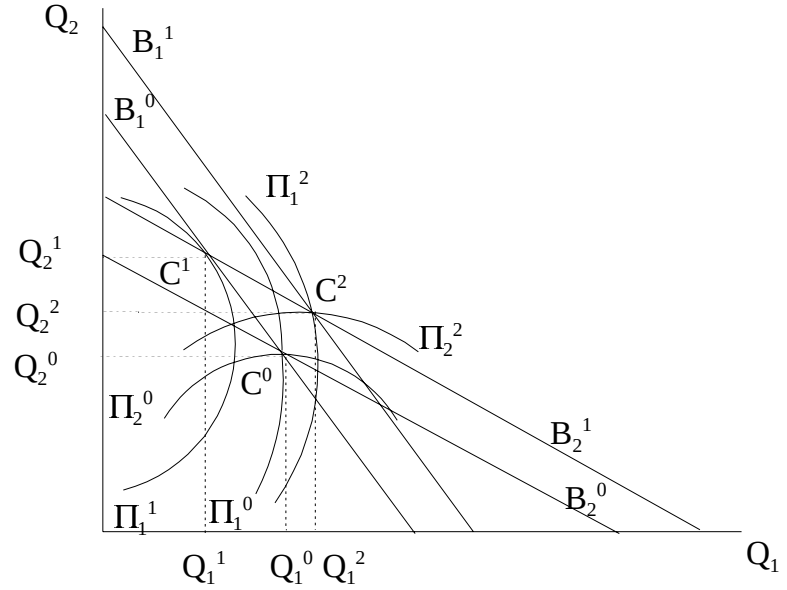


Figure 4: Domestic Subsidy under Duopoly: Strategic Complements

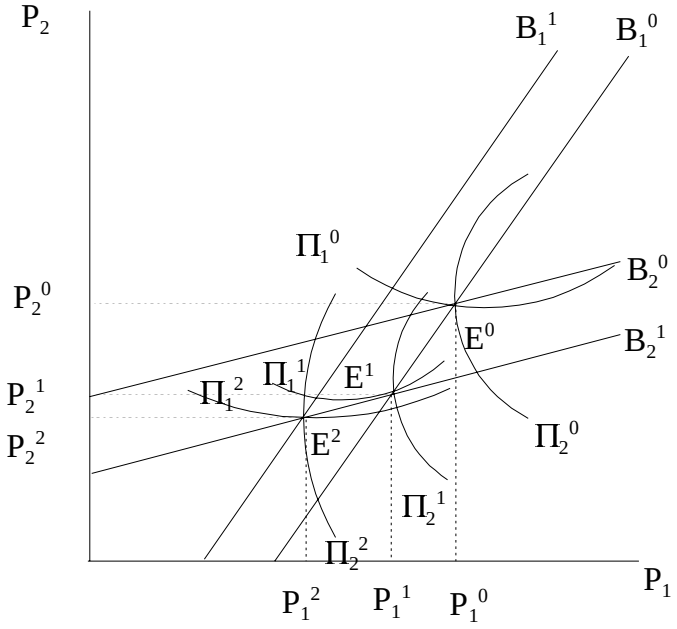
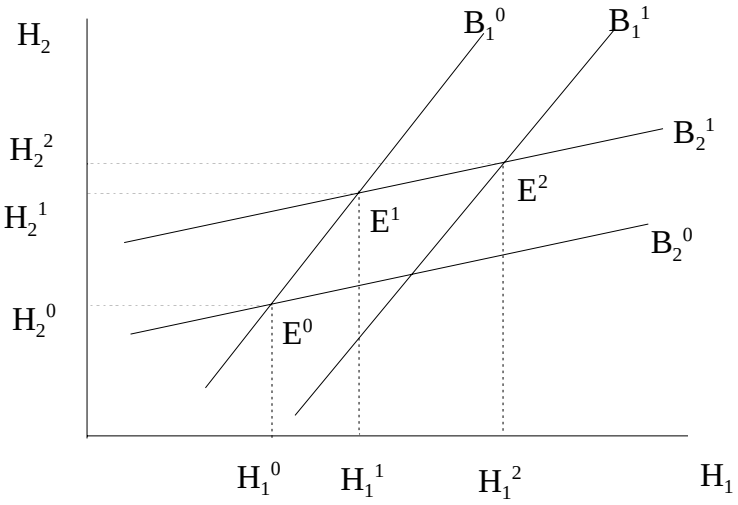


Figure 5: Domestic Subsidy under Duopsony: Srategic Complements



**Appendix**

This appendix derives the best response functions used in figures 3, 4 and 5 to verify that the shifts in those functions are as shown. The market described considers a duopoly with the home country duopolists denoted firm 1 and firm 2. Demand is linear and marginal cost is constant.

Strategic Substitutes: Cournot

In this case firms each set their output assuming the rival firm does not change its behavior. That is, the conjectural variation by firm i of firm j's response, $dq_j/dq_i = 0$. The good is assumed homogeneous so there is a common market price, P. The linear demand, which includes domestic and export sales, is:

(A1) $Q = Q_1 + Q_2 = \alpha - \beta P$.

For each firm there is a cost function, $C_i(Q_i)$, where $C_i/ Q_i = MC_i$, $^2C_i/ Q_i^2 = 0$, i = 1,2.

Assume each firm can obtain a subsidy, $s_i$, i = 1,2. Thus, profit for each firm, $\pi_i$, is:

(A2) $\pi_i = (P + s_i)Q_i - C_i(Q_i)$, i = 1,2.

Inverting the demand and replacing the price, then maximizing with respect to $Q_i$ assuming an interior Cournot solution for each firm gives the first-order condition for each firm:

(A3) $d\pi_1/dQ_1 = (\alpha/\beta) - 2(Q_1/\beta) - (Q_2/\beta) + s_1 - MC_1 = 0$;

(A4) $d\pi_2/dQ_2 = (\alpha/\beta) - (Q_1/\beta) - 2(Q_2/\beta) + s_2 - MC_2 = 0$.

Since figure 3 is drawn with $Q_2$ as the dependent variable equations (A3) and (A4) are rearranged to give the best response functions. For firm 1:

(A5) $Q_2 = \alpha + \beta s_1 - 2Q_1 - \beta MC_1$.

For Firm 2:

(A6) $Q_2 = (\alpha/2) + (\beta s_2/2) - (Q_1/2) - (\beta MC_2/2)$.

As can be seen, the best response functions have the properties shown in figure 3. They are linear and negatively sloped. The best response function for firm 1 is steeper than that for firm 2. Each function is only directly affected by the subsidy to that firm. Increases in a subsidy shifts the functions outward.

In the duopsony case it is assumed that packers face a pork price, P, determined by the world market, but influence the hog price, H, by the number of hogs slaughtered, $K_i$, i = 1, 2. Define the supply of hogs to packers as:

(A7) $K_1 + K_2 = \alpha + \beta H$.

The best response function for packer 1 is:

(A8) $K_2 = \alpha + \beta( Q_1/ K_1)(P + s_1) - 2K_1$.

The best response function for packer 2 is:

(A9) $K_2 = (\alpha/2) + (\beta/2)( Q_2/ K_2)(P + s_2) - (K_1/2)$.

Like the best response functions for the duopoly, (A5) and (A6), those for the duopsony, (A8) and (A9) are negatively sloped, the best response function for packer 1 is steeper than that for packer 2, and the subsidies have positive signs in all functions.

<u>Strategic Complements: Bertrand</u>

In this case there is price competition. Firms believe that if they change their price, their rival will maintain a constant price, or $dP_j/dP_i = 0$. If firms produce a homogenous product and have equal constant marginal costs with no capacity constraints, marginal cost pricing is obtained. In the example used in the text, firm 2 has a cost advantage. The outcome is that both firms will

price at firm 1's marginal cost with only firm 2 earning positive profits.

In this case, demand for firm 1's output depends on its price and the price set by its rival, firm 2:

(A10) $Q_1 = a_1 - b_1P_1 + b_2P_2$.

The demand for firm 2's output depends on its price and the price charged by firm 1:

(A11) $Q_2 = a_2 - \gamma_2P_2 + \gamma_1P_1$.

The general problem formulation is:

(A12) $\pi_i = (P_i + s_i - MC_i)Q_i(P_1,P_2)$.

Finding the first-order conditions and rearranging such that $P_2$ is the dependent variable gives the best response functions. For firm 1:

(A13) $P_2 = -(a_1/b_2) + (2b_1/b_2)P_1 + (b_1/b_2)s_1 - MC_1$.

For firm 2:

(A14) $P_2 = (a_2/2\gamma_2) + (\gamma_1/2\gamma_2)P_1 - (s_2/2) + (MC_2/2)$.

From equations (A13) and (A14) the best response functions are positively sloped. When the demand properties are imposed on $b_i$, i = 1,2 and on $\gamma_j$, j = 1,2, the best response function for firm 1 will be steeper than that for firm 2. The sign on the subsidy terms differs in the two response functions. In the case of firm 2 a subsidy lowers the price that firm offers— shifts the best response function downward, equation (A14). A subsidy given to firm 1 raises the price offered by firm 2, equation (A13). That is, firm 1's best response function shifts upward.

For the duopsony the pork price is set and packers decide the hog price, $H_i$, i = 1,2. The hogs supplied to each packer depend on the price that packer pays and the price offered by its rival. For packer 1 define this supply as:

(A15) $K_1 = a_1 + b_1H_1 - b_2H_2$.

For packer 2 the supply is:

(A16) $K_2 = a_2 - \gamma_1H_1 + \gamma_2H_2$.

The best response function for packer 1 is:

(A17) $H_2 = (a_1/b_2) - (b_1/b_2)( Q_1/ K_1)(P + s_1) + (2b_1/b_2)H_1$.

The best response function for packer 2 is:

(A18) $H_2 = -(\alpha_2/2\gamma_2) + ( Q_2/ K_2)(P + s_2)/2 + (\gamma_1/2\gamma_2)H_1$.

The response functions given by (A17) and (A18) are positively sloped as is the case for duopoly and that for packer 1 is steeper. However, the signs on the subsidies switch because the response function are defined with respect to an input price rather than an output price.